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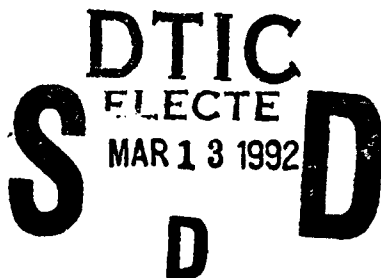
Strategic Defense Initiative Organization  
Department of Defense  
Attn: Mr. James A. Dryden  
The Pentagon, Room 1E1037  
Washington, D.C. 20301-7100

Subject: Delivery of Task Order 42 Final Report on Defenses and Disincentives to Proliferation (DII A332)

Dear Mr. Dryden:

Attached please find Task Order 42 Final Report on Defenses and Disincentives to Proliferation. This is in compliance with DII A332 as specified in the Task Order. This Final Report is an effort of DSA who has been actively engaged in supporting Task Order 42 throughout its period of performance.

If you have any questions, please contact me at (703) 351-6229.



Very truly yours,

Task Order 42 Manager

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**DEFENSES AND DISINCENTIVES TO PROLIFERATION**

**10 JANUARY 1992**

**Prepared for:**

**Deputy for Operations  
THE STRATEGIC DEFENSE INITIATIVE ORGANIZATION  
The Pentagon  
Washington, D.C. 20301-7100**

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**Prepared by: F. Stephen Snipes  
Paul E. Scesney**

**THE ANALYTIC SCIENCES CORPORATION  
1101 WILSON BOULEVARD  
SUITE 1500  
ARLINGTON, VIRGINIA 22209**

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Statement A per telecon James Dryden  
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## **1.0 INTRODUCTION**

The proliferation of ballistic missiles and their associated technologies through the Third World has become a chief security concern for the United States and its allies. To meet this threat, the U.S. and other industrial nations have attempted to impose export controls on critical missile technologies in order to prohibit certain regimes from acquiring ballistic missile systems. Unfortunately, the controls have largely been ineffective as not only have ballistic missiles been acquired by dangerous Third World regimes, but often the technology and engineering expertise to indigenously produce these weapons have been obtained as well.

Two major instances of ballistic missile use in the Third World--the Iran-Iraq War of the Cities and Desert Storm--have brought home the realization that arms control measures alone are not going to be successful in stopping proliferation of these weapons. Other responses to these systems are needed to enhance current arms control efforts.

One of these responses is active ballistic missile defense. Desert Storm demonstrated the utility of defenses as a response to the products of proliferation. Less obvious, but of great interest to SDI and U.S. foreign policy is how this demonstration of defensive prowess and subsequent development in defensive technologies will affect ballistic missile proliferation. The presence of defenses reduces the value of ballistic missiles that is determined by a potential proliferator. By doing so, defenses provide disincentives for regional countries to proliferate. Examining these disincentives is an integral part of determining the net value of defensive deployments.

### **1.1 FOCUS OF PAPER**

This paper examines the effects defenses have on a proliferator's or potential proliferator's decision to procure ballistic missile systems. For the proliferator, the motivations for acquiring ballistic missiles are detailed to examine the factors of these systems that make them valuable. After examining the motivations of the proliferating country, possible responses of neighboring countries are evaluated. At present, the most obtainable response is to also acquire ballistic missiles, thus creating an arms race. An emerging response, however, is to procure defenses to defend against a proliferator's ballistic missiles or against those of all proliferators in a region. This paper discusses the defense option in relation to how it affects overall regional arms races, and implications these effects have for SDI and U.S. foreign policy.

Overriding these descriptive purposes is an attempt to determine some key quantitative measures of defenses' dissuasiveness to proliferation. These measures describe some of the effects defenses have on the economic, strategic, and political aspects of ballistic missiles and illustrate the reduction in benefits that proliferation provides a country in the presence of defense. These measures cannot fully describe

the benefits of defenses in fighting proliferation; nonetheless, they can demonstrate some of the influence defenses have on regional arms races in a more meaningful manner than the traditional measures that were used in describing the U.S.-Soviet arms race.

## 1.2 THE NITZE CRITERIA AND GPALS

In the former U.S.-Soviet strategic relationship, defense planners sought to ensure that defenses would not destabilize the strategic balance and worsen the arms race by subjecting a prospective defense to the Nitze Criteria. The Nitze Criteria were military effectiveness, survivability, and cost effectiveness at the margin (CEATM). CEATM was the measure linked to ensuring against an arms race, and it was for this criterion that Nitze's name is most closely associated.

A traditional anti-arms race measure, CEATM measures the relative costs of extra defenses to the costs of the added offenses that are to be countered at the margin. "At the margin" indicates that the relative costs are assessed only for the additions to the offense and defense not the costs of deploying the original systems. CEATM was intended to apply vice one opponent who had the time, money, technology, and desire to counter the defenses.

In context of the U.S.-Soviet strategic balance, to prevent the Soviets from adding systems to overcome a deployed defense, the defense had to be less expensive to upgrade than the offensive weapons the Soviets deployed. If that were true, the Soviets would have a reduced incentive to deploy extra systems, since the U.S. could counter these additions at less expense. In practice, the measure was slightly more complicated because of the distinction between absolute cost and relative affordability, but the basic principle remained: a system had good cost effectiveness at the margin if the additional defense necessary to countervail marginal offensive deployments were more affordable than the additional offenses.

The importance of CEATM in evaluating proposed defenses has waned as the threat from the remnants of the Soviet Union has declined. CEATM has also waned in importance with the proliferation of strategic offensive systems to more hostile and less stable regimes that has prompted a redefining of the goals for U.S. strategic defense. The original goal versus the Soviets was to strengthen U.S. deterrence by complicating a Soviet first-strike attack. In this case, assuring that the Soviets could not afford a counter was important to maintaining arms race stability. Now, however, a general first strike from the ex-Soviet, nuclear-capable republics is considered extremely unlikely and is viewed as less of a threat than an unauthorized or accidental Soviet attack, or an attack from a proliferating country. In these cases of accidental, unauthorized or limited strikes (AULS), albeit for different reasons, the attack is expected to be small enough that the U.S. would have enough defensive assets to intercept all attacking warheads.

To meet this more likely threat, the U.S. seeks to provide a Global Protection Against Limited Strikes (GPALS). Not only providing protection from limited strikes for the U.S., GPALS would also be able to defend against ballistic missile launches no matter what the source or destination. Obtaining good CEATM against strikes "from anywhere to anywhere" is more difficult, however. This is largely due to range considerations.

As an attacker's missile range decreases, good CEATM gets more and more difficult to achieve for several reasons. First, decreasing range means that a smaller fraction of space-based interceptors (e.g., Brilliant Pebbles) can be brought to bear. Compounding this problem is the fact that defense reaction time becomes a greater fraction of overall battle time thereby putting increased performance demands on the defense if it is to remain effective. Finally, while the cost of high-technology interceptors is still fairly high even for short-range intercepts, the cost of the ballistic missile can fall dramatically as range shortens, especially if the missiles are of a low-technology type (e.g., SCUDs).

Congress has required that, by law, any deployed ballistic missile defense must meet the Nitze criteria. Although this legal requirement was intended only vis-à-vis the now defunct Soviet strategic threat, it is still possible that Congress may apply the law to GPALS even when it may not be relevant to the missions of GPALS. GPALS is composed of a National Missile Defense (NMD), Theater Missile Defense (TMD), and Global Missile Defense (GMD). Missions of GPALS include defense of the U.S., defense of U.S. allies, and defense of U.S. and allied forces overseas. For the purpose of this paper, it is convenient to repackage GPALS considerations in terms of two key missions, i.e., U.S. Defense (provided by NMD and GMD) and Regional Defense (provided by TMD and GMD). As will be discussed below, CEATM's relevance to these two key missions is overstated and other measures are probably needed to illustrate the anti-proliferation value of GPALS.

### 1.3 U.S. DEFENSE AND CEATM

Presently in providing a U.S. defense, SDI is most concerned with the former Soviet arsenal. The possibility that some of these weapons could be launched without the authorized national command is the most immediate threat to the continental United States. GPALS will provide protection from these types of strikes.

CEATM for AULS is not relevant in regard to the ex-Soviet arsenal, however. GPALS will not threaten Russian deterrence, and thus provides them with no incentive to deploy additional offenses beyond START-constrained levels. Furthermore, it is meaningless to postulate that additional missiles will be accidentally launched "at the margin"; nonetheless, ensuring that a U.S. defense is cost effective at the margin may still be desirable.

CEATM's relevance to U.S. defense arises from the future threats to the U.S. presented by proliferating powers. The growing Soviet threat of the past may be very similar conceptually to the proliferating country's growing threat tomorrow. To discourage any proliferator from entertaining thoughts of strategic rivalry with the U.S., a deployed national defense should meet CEATM requirements. Given the long strategic missile ranges involved in attacks on the U.S., favorable CEATM should be obtainable.

#### **1.4 REGIONAL DEFENSE AND CEATM**

At present, however, proliferation is being driven by regional security issues. In these issues, a defenses' effects on regional arms races are not captured by CEATM. So although good CEATM is difficult for defenses to obtain in shorter-range regional missions, this is less significant than in the U.S. defense case because CEATM is not necessarily an appropriate measure of the usefulness of the defense. This section outlines the problems of using CEATM to determine defenses' effects on regional proliferation and regional arms races.

One problem with CEATM is that it is a bilateral measure. Thus, its use to evaluate cost effectiveness of a defense versus a single opponent may be questionable, when, in a case like GPALS, such defenses may provide regional defense protection against every other opponent as well. So while denying all possible targets from a specific attacker may decrease CEATM, the additional leverage extra defenses gain versus other attackers is shortsightedly ignored.

Additionally, CEATM's use of affordability as the chief criterion of whether additional offenses will be deployed is suspect when comparing the U.S. and regional powers. Regional countries simply do not have the wherewithal, even with a favorable cost exchange, to compete with the U.S. in an arms race. Regional countries face severe restraints on their development program relating to such things as limits on fissionable materials as well as economic constraints of limited technology and resources. Furthermore, cost effectiveness *at the margin* assumes that countries will obtain offenses that reach the margin of the deployed defenses, forcing additional defensive deployments. This is likely not to be the case when there are severe limits on a proliferator's funds, fissionable nuclear materials, or other critical resources needed to continue prolonged increased acquisition of ballistic missiles.

#### **1.5 OVERVIEW**

Of SDI's two key missions for GPALS mentioned above, this paper is primarily concerned with defense against regional powers. Specifically, how will defenses affect the desires of these countries to obtain ballistic missiles? As mentioned above, the traditional CEATM measure to evaluate arms race potential in deployments is not fully appropriate to this situation. This paper will detail the

arms race dynamic present, outline other possible measures, and evaluate the implications of the use of these measures.

Sections 2 and 3 present the regional arms race dynamic from the perspectives of the proliferating country and the regional countries facing proliferation, respectively. Section 4 then discusses the defenses' impacts on proliferation decisions and presents measures for quantifying some of these effects. Section 5 assesses the implications of defenses' disincentives to proliferation for SDI and U.S. foreign policy, and how the use of the quantitative analysis presented in section 4 can aid SDI's integration into U.S. anti-proliferation strategy. Section 6 concludes by suggesting further work to explore the development and promotion of more meaningful measures in multilateral, regional strategic relationships.



## **2.0 MOTIVATIONS TO PROLIFERATE**

Ballistic missile systems have military, strategic, and political value for regional countries. The military value of strategic systems is focused in the ballistic missile, i.e., the delivery system. The strategic value of these systems rests on the ability to couple ballistic missiles with mass destruction munitions for the purpose of holding at risk significant amounts of the opponent's value structure, i.e., strategic deterrence. The political value is existential--having or implying a strategic deterrence capability--and is enhanced if indigenous production capabilities are also obtained. Each of these values motivates states to acquire, modernize, and produce offensive strategic ballistic missiles.

### **2.1 THE MILITARY VALUE OF BALLISTIC MISSILES**

The military value of ballistic missiles can be roughly categorized by two sorts of roles, i.e., tactical strikes and strategic strikes. In tactical strikes, ballistic missiles are used against traditional military targets such as troop concentrations, airfields, and supply depots. In strategic strikes, ballistic missiles are used against value-type targets such as leadership, population, and industry. The chief, albeit gray, distinction being the immediacy of effect. Tactical strikes are intended to have direct effect on the course of hostilities, while strategic strikes are intended to apply indirect pressure by attacking targets of long-term war support or to apply coercive pressure by threatening further escalation to other targets of value.

Ballistic missiles are perceived by many regional powers as having significant military value in both of these roles. Key aspects of these systems are their speed of attack, assurance of penetration, range, and the fact that they are an affordable and well-understood technology. Ballistic missile limitations, compared to aircraft, are their accuracy, payload, and in some cases, cost-effectiveness.

If armed with conventional explosives, the accuracy of present day Third World ballistic missiles limits them to tactical strikes utilizing massed barrage or harassing strategic strikes utilizing city bombardment. But ballistic missiles can also be used to deliver chemical and biological warheads, which coupled with lack of warning or lack of adequate protection, could produce effective attacks against not only cities but also military troops and military installations as well. The next generation of Third World ballistic missiles' improved accuracy, range, and payload, coupled with the potential for advanced munitions such as fuel air explosives and submunitions, promise to further enhance tactical effectiveness.

The fact that aircraft seem to provide the more cost-effective way to accomplish most of these missions has not dampened countries' enthusiasm to acquire ballistic missiles. Regional powers have to import their aircraft, have difficulty maintaining them and have limited numbers of trained pilots, while ballistic missiles have the potential to be produced indigenously, require less skilled crews, face smaller chance of intercept and, as seen in Iraq, have a better chance of being

hidden from attack. Also, as in the case of Iran, air forces may be husbanded for easier missions like air defense and population control.

## **2.2 STRATEGIC DETERRENCE VALUE OF BALLISTIC MISSILES**

A more concerning motivation for ballistic missiles is to marry them with mass destruction capabilities for strategic deterrence. On security grounds, strategic deterrence is desirable as an ultimate guarantor of a country's integrity. Many regional countries face immediate and explicit threats to their very existence making possession of strategic deterrence appear a necessity. Other countries may not face immediate and direct threats, but nevertheless face countries that have strategic capability and who cannot be considered indefinitely nonbelligerent. Strategic deterrence can be utilized to deter both conventional and nonconventional attacks from these perceived threats.

Another security benefit of having a strategic deterrent is the effect it can have on extra-regional powers who seek to influence the region. Strategic deterrence raises the stakes for power projection into the region thereby increasing the threshold of intolerable actions that will prompt global power intervention. A strategically capable Iraq would have posed significant problems for Desert Storm. Every member of the coalition would have had greater doubts about the appeal of a military solution when faced with a nuclear capable adversary. For the Arab countries, the linchpins of the coalition, being directly under the missile attack envelope probably would have precluded allowing offensive operations to liberate Kuwait. The same might have applied to support by western powers given the danger to their forces in the region. Indeed, had Iraq waited to invade Kuwait until it had obtained a credible nuclear deterrent, the world might still be waiting on economic sanctions.

## **2.3 POLITICAL VALUE OF BALLISTIC MISSILES**

Possessing strategic deterrence provides countries with political influence far beyond their military or economic capabilities. Capabilities in strategic systems announce the prowess of a country's science, economy, and diplomacy with an immediacy that foreign trade and GNP statistics cannot. Britain and France are illustrative of this point. The high degree of these two countries' international prestige is not solely a product of their economic influence or conventional military capabilities, but rather has much to do with their nuclear arsenals.

To a large extent, the political and deterrent benefits accrue simply by having a demonstrable ability to produce strategic systems without necessarily possessing any weapons. In this manner some deterrence may be established without any international recriminations. This has been India's approach, which has detonated a "peaceful" nuclear device. India now has a de facto nuclear deterrent even while claiming it has produced no nuclear weapons.

Clearly the ballistic missile's role in providing strategic deterrence is not essential. Other means of delivering mass destruction weapons are available. Conversely, in a limited sense, ballistic missiles provide a small amount of strategic deterrence, and the resulting political value, without mass destruction warheads. The combination of the two is most attractive, however. As mentioned above, ballistic missiles presently provide an assurance of penetration, range potential, and speed of attack not readily available in aircraft. Thus, the proliferation threat the world is witnessing is largely of complementary character, as countries tend to pursue a combination of both ballistic missiles and weapons of mass destruction.

### **3.0 POSSIBLE REGIONAL COUNTRY RESPONSES TO PROLIFERATION**

Proliferation of ballistic missiles in a region can disturb both the countries within the region and global actors with interests in the region. Of largest concern are regions where ballistic missiles are part of an overall strategic program aimed at obtaining strategic deterrence. Not only do regional countries have to be concerned with the security threat from ballistic missiles, but those that do not have these systems must also be concerned with an erosion of political influence.

A regional country's potential responses to a proliferation threat are limited. Possible responses are preemption via offensive strike, deterrence via threatened retaliation, defense, or some combination of threatened deterrence and defense. This section examines these possible responses and points out the difficulty in establishing stable multilateral deterrence based on offensive systems alone.

#### **3.1 PREEMPTION VIA OFFENSIVE STRIKE**

The use of preemption to arrest proliferation is best illustrated in Israel's 1981 attack on the Osirak nuclear reactor. Using a preemptive strike, the Israelis slowed Iraq's nuclear development by destroying its main domestic source of nuclear weapons material. Despite the qualified success of this action, preemption does not look like a promising prospect for future proliferation problems. As the U.S. discovered in Desert Storm, the demands on intelligence and strike capabilities for preempting against ballistic missiles are currently beyond the capabilities of regional countries.

Israel had the benefit of targeting only one facility, but a missile program can be very dispersed, clandestine, and mobile. Also, preemption of ballistic missiles is diplomatically problematic. A country that preempts generally needs to make a case for its national security being imminently threatened. Ballistic missiles and nuclear power separately may not represent a demonstrable national security threat, even though they might imply it. In sum, anti-proliferation preemption is not generally diplomatically acceptable as part of normal peacetime policy and, even in warranted circumstances, may be quite difficult to accomplish.

#### **3.2 DETERRENCE VIA OFFENSE**

Another response to proliferation is to deter by threatened retaliation. However, the success of deterrence depends on the rationality of the party being threatened and on the credibility of the threat. Currently, the way to assure credibility is to obtain significant strategic offensive capabilities and show determination to use them. Conventional deterrence is not likely to be threatening enough nor immediate enough for great confidence in deterring the use of ballistic missiles in strategic roles. This is especially true if the two adversaries are already conventionally engaged and strategic weapon use represents only escalation.

Even between two regional adversaries with similar strategic capabilities, deterrence is not assured because it also depends on stable political systems, a proper assessment of the other's capabilities and intentions, and rational regimes that logically respond to such situations. These requirements are lacking in many regions of the world. The potential for misinterpreted escalation is exacerbated by the fact that regional countries are undeclared powers, making it impossible for the countries to discuss their programs. India and Pakistan have admitted that they lack solid confidence in their assessments of each other's nuclear programs and deterrence doctrines. Furthermore, as in the case of Iraq in the Persian Gulf War, escalation may be deliberately used to provoke a response and broaden a conflict.

Aside from the instability in undeclared deterrence, regional offensive deterrence is also difficult due to its multilateral aspect. The vicious dynamic of multilateral deterrence is that while increasing its offensive threat can make a state's deterrent marginally more credible, the increase has the potential to provoke multiple responses throughout the region. As one state adds missiles, it could induce responses from several of its neighbors that are, in sum, many times the initial addition. These responses then can lead to numerous counterresponses resulting in an exponentially growing multiparty regional arms race.

Another effect of proliferation of more sophisticated systems is longer range. This can induce further expansion of geographical arms races as countries increase their strategic capabilities far beyond their immediate neighbors or immediate political threats. Since countries often desire to respond to capabilities as well as intentions, this geographic threat expansion can provide a powerful arms race driver. If the multilateral and geographical threat expansion produced by a single country modernizing is coupled with the instability of many regional political regimes, then simply hoping for a stable transition to non-conventional deterrence is at best very optimistic.

### **3.3 DEFENSES**

Another option for a country facing a potential threat from ballistic missiles is to provide an active defense against them. Missile defenses deter the use of ballistic missiles by denying them their ability to accomplish their objective. The strength of such deterrence by denial depends, of course, on the effectiveness of the defense against the offensive threat. In addition to deterrence by denial, defenses also provide the extra benefits of avoiding or limiting damage should deterrence not hold.

For regional countries, however, defenses are a demanding option. At present there are no available effective ballistic missile defenses in the Third World other than what the U.S. or Soviet Union lends or sells. While there are development programs like the Arrow in Israel and the Al Faw 1 in Iraq, anti-missile technologies in the Third World are now clearly subordinate to offensive technologies and are likely to remain so for years to come.

Regional nations must currently rely on foreign purchases if they desire to counter their present proliferation threats with ballistic missile defenses. The supplier base for defenses is small, and the sophisticated technology is difficult to reproduce or re-engineer, contrasting sharply with the market for offensive systems. Thus, pursuing a defense-only option allows for less operational autonomy than offensive systems for regional countries.

### **3.4 OFFENSE-DEFENSE COMBINATIONS**

Despite the fact that countries would rather put their money into security systems that they can control, Desert Storm demonstrated the value of missile defense and has whetted appetites for these systems. Recent PATRIOT sales to Saudi Arabia are one example. This is not to say that offensive deterrence can be supplanted, but if alternatives are available, countries might favor an offense-defense balance rather than relying solely on threatened retaliation via offense. To see if this might be the case, the paper now addresses the disincentives to proliferation that may be created by regional defenses.

#### **4.0 DEFENSES' DISINCENTIVES TO PROLIFERATION**

For every weapon system, the introduction of a counter or defense to that system alters the perceived value of the system. This section will examine the impacts defenses have on the strategic and political value of ballistic missiles. For the strategic value, quantitative measures of the limitations defenses impose on strategic missions are developed. The political impacts such as added flexibility in response and enhanced regional security are harder to quantify but these are discussed qualitatively in the second subsection.

#### **4.1 REDUCING STRATEGIC UTILITY AT THE MARGIN**

The quantitative measures presented below indicate a defense's reduction in the value of ballistic missiles as they apply to strategic strikes and in some cases to tactical strikes. Analysis is conducted "at the margin" for much the same reason that CEATM looked at the margin for the U.S. and Soviet confrontation, i.e., its applicability to a proliferator's evaluation of procurement decisions. In this case, however, a key margin examined is the proliferator's decision to procure or produce even one strategic ballistic missile (for reasons outlined in subsection 1.3). Three measures of a defense's dissuasiveness to proliferation are examined below: higher relative cost per penetrator, reduced scope of geographic influence, and reduction of escalation options.

##### **4.1.1 Higher Relative Cost Per Penetrator**

One major aspect of ballistic missile value that was discussed in Section 2 was the missile's high assurance of penetration. This only follows, of course, if there is no defense present. An introduced defense raises the cost to the offense to assure a penetration, because, on average, more missiles have to be fired before one is expected to penetrate the defense. This increased relative offense cost to counter a defense can be measured for a particular proliferator's ballistic missiles against certain defense deployments. A useful measure is the new higher total number of weapons (or weapons with countermeasures) the proliferator will need to keep his original targeting confidence coupled with some cost assessment for those weapons (and countermeasures). This measure will be referred to as the relative cost per penetrator (RCPP).

Several separate applications of RCPP apply. One deals with a target that is only defended by ground-based interceptors, another deals with a target that is only defended by space-based interceptors, and a third deals with a target which can be defended by both ground-based and space-based interceptors. While the combination of both ground-based and space-based defense may be the best architecture, for the purposes of this paper we will confine ourselves to a rough sketch of the nature of RCPP for ground-only and space-only defenses. The more complex combinatorial case depends on many scenarios-dependent factors but it will

incorporate aspects of the other two cases in different measures. In some cases, however, it will simply be the product of the two functions discussed below.

The first case examined is that of an asset or area defended only by ground-based interceptors. For the sake of this examination, attacks on such targets can be assumed of short enough range that space-based interceptors do not make a significant contribution to the defense (or that space-based interceptors are not present) and that only ground-based interceptors play. Unless the offense is able to overwhelm the defense, the chance of a penetration depends mostly on the effectiveness of the defense, that is, the probability the defense allows a "leaker". The probability of achieving a certain number of hits, of course, increases as more missiles are fired.

Figure 1 nominally illustrates the relative cost per penetrator presented to an attacker for different levels of defense effectiveness. The figure illustrates the sharp rise in the number of weapons required (and hence cost) to maintain the expectation of a penetrator for only modest increases in the effectiveness of the defense. Of course, as the curve indicates, this only holds up until the defense is saturated or exhausted. At that point, the marginal relative cost per penetrator will equal the no defense case as indicated by the break point in the graph.

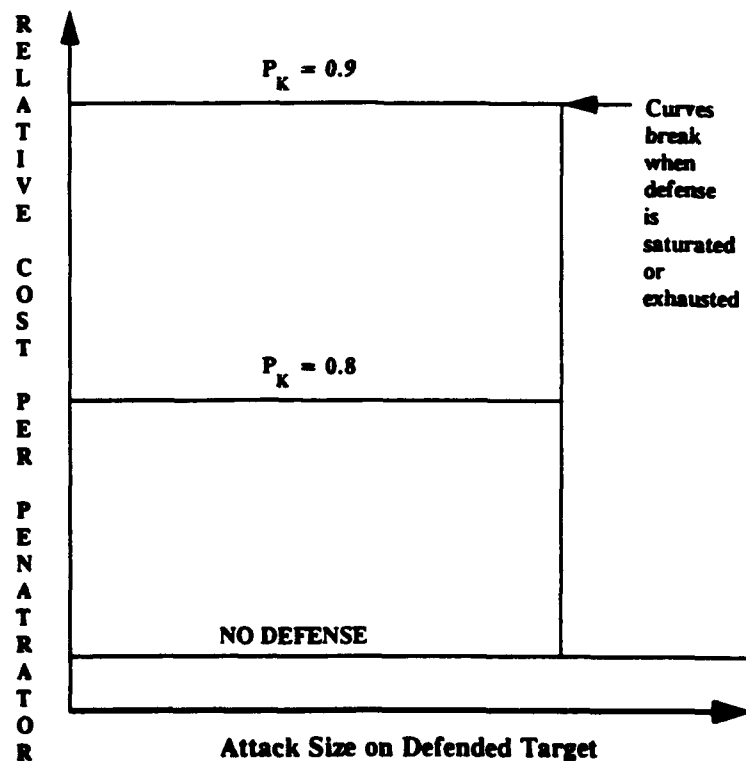


Figure 1. Relative Cost per Penetrator for Target Defended Only by Ground-Based Interceptors



In designing the defense of a region, certain key targets such as capital cities will warrant defense by ground-based interceptors. Increased relative cost per penetrator such as that in Figure 1 will therefore have a significant impact on a proliferator. No longer can he acquire only one or few ballistic missiles and threaten the single most important asset of a country. Instead he must acquire many more ballistic missiles to threaten that asset or settle for attacks on much less important undefended targets which will mean much less leverage or effectiveness associated with the ballistic missiles that are acquired.

By reducing the value of attacking selected key targets and forcing an attacker to strike secondary targets, the stage is set to demonstrate the value of space-based interceptors. It will be very difficult and very costly to provide ground-based defenses in all potential targets in a region. In this situation, the leverage of space-based interceptors in defense against AULS "from anywhere to anywhere" is significant, and the impact of space-based elements increases as the range of the missile strike increases. The longer the range, the more responsive a space-based defense like GPALS can be. Against short-range AULS space-based interceptors may not be able to play, but as the range of the AULS increases more space-based interceptors will play. As the desired range of an attacker's strike increases, he must therefore launch more and more missiles or countermeasures to assure penetration of the space-based defense (even if the target is not defended by ground-based interceptors). The higher number of missiles or countermeasures required to accomplish the attackers mission can be readily translated into a cost per penetrator measure. Hypothetical results for this type of analysis are shown below in Figure 2.

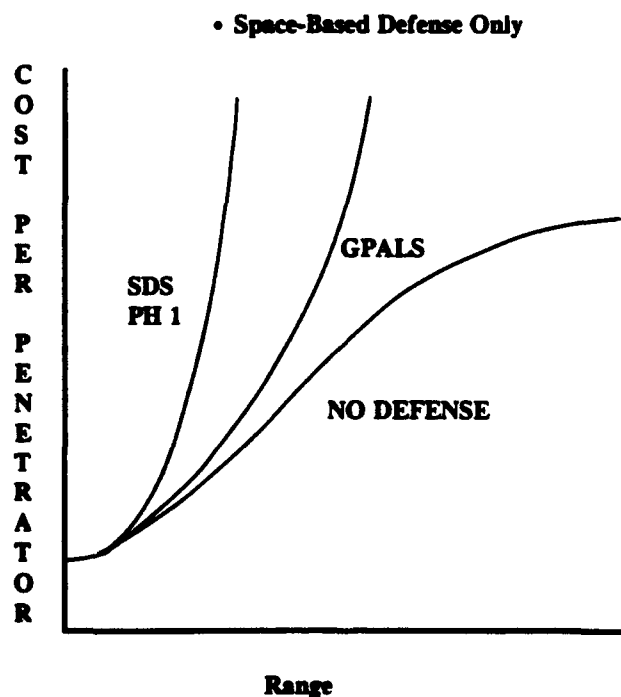


Figure 2. Cost Per Penetrator Versus Range for  
Case with Space-Based Defense Only

This graph shows that in absence of a defense, the cost curve traces the increased expense required for the missile as its range increases. Longer range missiles naturally being more expensive than shorter range missiles. The curve tends to flatten out as orbital ranges are approached. Thus, there is a significant amount of decreasing marginal cost in obtaining longer range systems when there is no defense present. In the absence of space-based defenses, this decreased marginal cost will encourage regional powers to try to become strategic powers with missiles of very long range.

The ability of a space-based defense to sharply attenuate long-range attacks, however, increases the cost per penetrator especially over the longer ranges. From the figure it is evident that, unlike the no defense case, with space-based defense elements the marginal penetrator cost for additional range continues to rise. Thus, space-based elements deny "economies of range" that would normally be a large incentive to pursue longer range systems.

This denial of benefits of longer range systems is clearly illustrated in Figure 3 below. This figure shows the relative cost per penetrator of the two defense cases normalized to the no defense case. The sharp elbows in the curve give indication that long range power projection is priced out of a proliferator's affordability by global defenses.

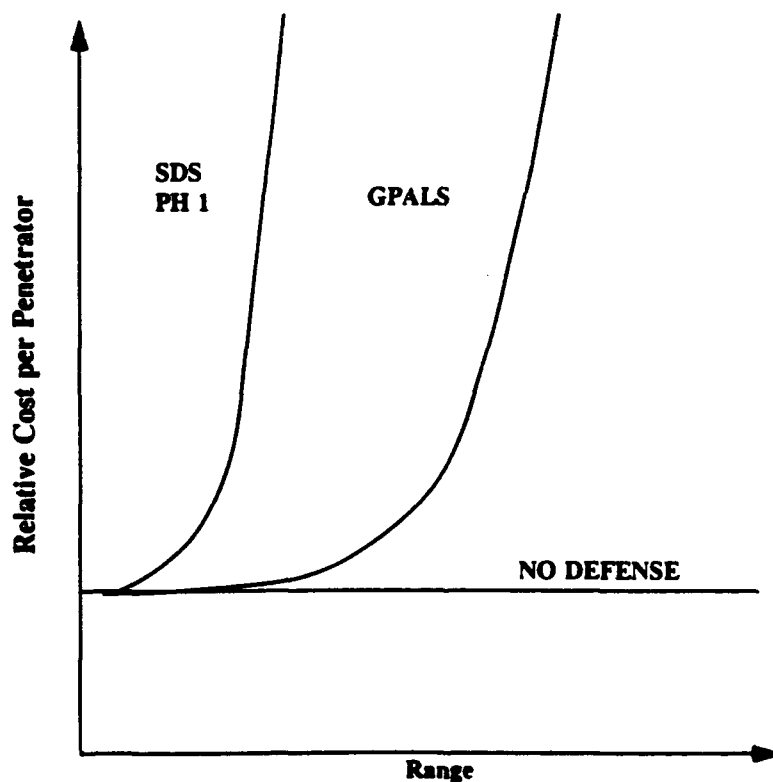


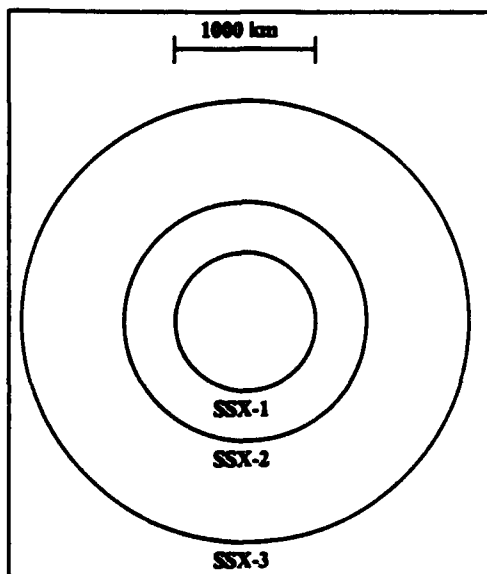
Figure 3. Relative Cost Per Penetrator with Space-Based Defenses

#### 4.1.2 Reduced Geographic Scope of Influence

As indicated by the RCPP measure, global defenses particularly reduce incentives for longer range systems. Therefore, another measure of the reduction in utility for longer range systems provided by space-based, global defenses is the amount of unrestricted coverage area ballistic missiles have in the defense case versus the no-defense case. GPALS with space-based defense can reduce the threats posed by ballistic missiles of one nation to a radius much less than the missile's nominal range, thus eliminating strategic threats against many countries in a region. This limits and helps stabilize arms races in a region in which, as discussed in Section 3.3, countries try to deter everyone who has them under missile coverage. A deployed GPALS would provide for protection against long-range strikes by next generation missiles, sharply limiting the utility of pursuing these missiles. The coverage area limitation by space-based defenses for longer ballistic missiles is nominally illustrated in Figure 4 below. The figure shows target coverage for succeeding generations of ballistic missiles before and after a GPALS defense.

Graphically, the impact of space-based defenses is clear. Note, however, that even with global defenses, target coverage area will increase somewhat as missile ranges increase. This happens because longer range systems are faster, reduce defense reaction time for a given range, and can be used in a longer-range depressed-trajectory mode through which the missile may remain below the altitudes needed for space-based defenses to be effective. Nonetheless, the gain in area covered is slight compared to the increase in threatened area that would be obtained without defenses.

• Target Coverage Map without GPALS



• Target Coverage Map with GPALS

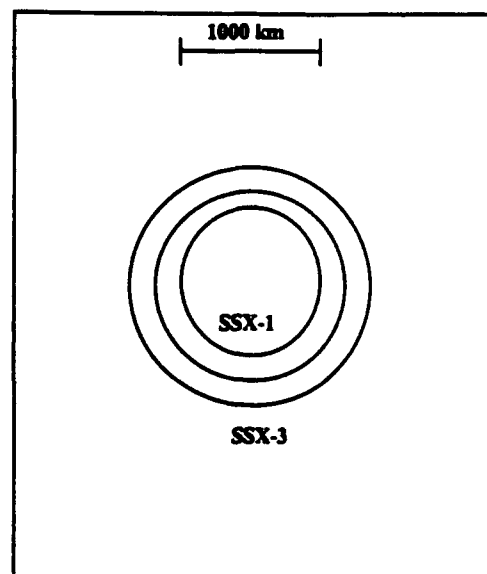


Figure 4. Realized Missile Coverage with GPALS

Quantitatively, each missile can be evaluated on a percentage of the nominal area obtained. The smaller this figure the less incentive for developing or obtaining the missile because less regional influence is implied. Figure 5 shows the realized coverage area of missiles with GPALS normalized to their nominal coverage. As is evidenced, GPALS sharply attenuates the geographic coverage of longer-range threats. This strong effect of GPALS allows nations in a region to consider deterring or defending only against neighboring or close threats, not against all conceivable in-range threats which would be identified without GPALS.

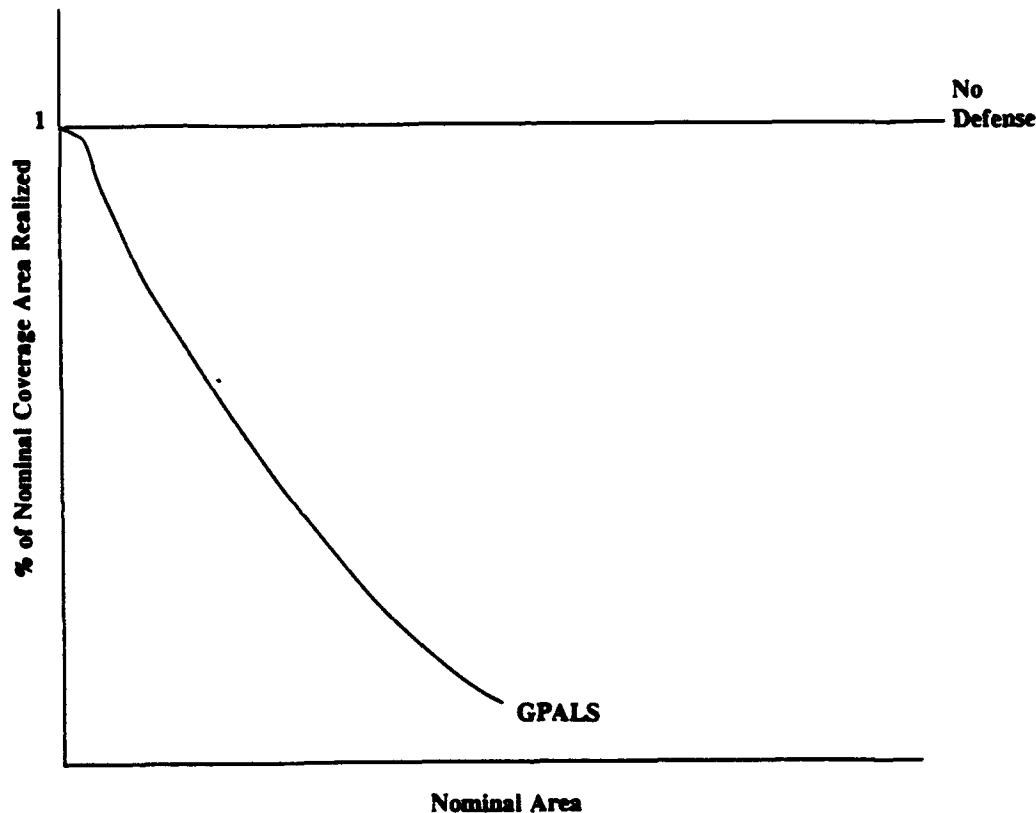


Figure 5. Realized Missile Coverage Normalized to Nominal Coverage

#### 4.1.3 Reduction of Escalation Options

Using target coverage maps like the ones shown in figure 4 above, specific measures of decreasing coverage utility can be made for particular strategic rivalries (such as India vs. Pakistan). By preventing coverage of certain targets, defenses force planners to choose targets of lesser value. More lesser-valued targets must be covered to threaten an equal amount of the adversary's value structure when compared with targeting in the no-defense case. Holding the same target value at risk requires more missiles, or alternatively, the same amount of missiles threatens less of the opponent's value structure. Figure 6, below, nominally illustrates this defensive impact for a ubiquitous target value such as population.

Note how many more missiles are expended by both countries to hold the same level of population at risk when defenses are present. Part of this is due to the global defense elements denying certain escalation options. The remaining additional expense is due to the extra missiles required for the still reachable, but now defended targets. The asset threatened in the example is population, but clearly other aspects of countries' value structures are affected similarly and can be evaluated in the same manner. The combination of space-based defenses plus judicious siting of ground-based defenses (e.g., in capitals and major cities) will do much to drastically reduce the utility of proliferator's ballistic missiles.

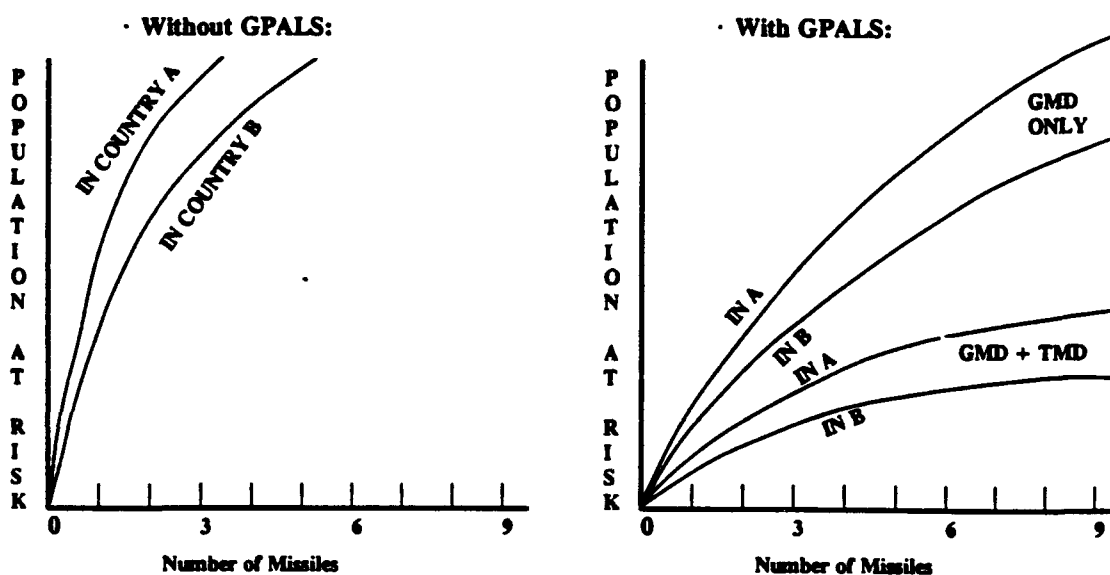


Figure 6. Reduction of Escalation Options

Here again the results could be normalized to the no defense case. However, the exact shapes of these graphs are not intuitively obvious from Figure 6 and so are not provided absent real data. In analysis of actual regions, however, such normalized graphs would aid interpretation.

#### 4.2 DEFENSES' EFFECTS ON POLITICAL VALUE

Defenses not only impact the strategic capabilities of ballistic missiles, but also impact the political value of the missiles as well. Defenses accomplish this by moderating regional arms races, providing flexibility for responding to proliferation, and strengthening a country's political influence without adding offensive systems.

Defenses moderate regional arms races by providing an alternative to adding offenses in response to regional proliferation. This allows for a country to meet its security needs without compounding threats to many neighboring countries.

Additionally, defenses allow for the provision of extra-regional assistance by protecting forces sent into the region from other powers. Defenses prohibit countries from assuming that international interest in regional disputes can be deterred through strategic offensive capability.

Another benefit defenses provide is increased flexibility in a crisis. An unusual, but important example of this being Israel's willingness to refrain from directly responding to Iraqi Scud attacks. Had there been no defensive option for the Israeli government, the pressure to respond might have been too much for restraint. Similarly, in the future, simultaneously sending defenses to several key cities in both India and Pakistan could do much to calm that region in future crises in which ballistic missiles are available to both sides. Deploying GPALS with space-based defenses would bring similar benefits to all potential rivalries.

Finally, defenses reduce the political benefit derived from being a strategically capable state. Defenses do this by providing an alternative system with cachet rivaling offense systems. Technically, defenses show as much prowess as offensive systems without the extra political tension. Thus, the arms transfers of defenses are less sensitive politically, yet still provide a way for a regional country to demonstrate it has the support of a major power.

Quantifying these political effects may not be possible, but the measures described in section 4.1 above can be extrapolated to give some overall indications for regional security. The increased relative cost per penetrator can indicate the added costs to proliferators throughout a region. Similarly, the shrinkage of coverage areas can be extended to an overall regional measure. Thus, by combining individual-proliferator measures, an assessment of defenses' effect on regional security and stability may be possible. Since regional security and stability are principal factors affecting the demand for ballistic missile and offensive strategic capabilities, the disincentives created by defenses may do much to slow proliferation by addressing its root causes.

## **5.0 IMPLICATIONS FOR U.S. POLICY AND SDI**

By affecting regional country calculations of the military, strategic, and political value of offensive strategic weapon systems, defenses can slow proliferation. Furthermore, defenses have the potential to accomplish this even though they are not cost effective at the margin for defending against all possible from-anywhere-to-anywhere threats. Defenses inhibit proliferation by:

- decreasing the effectiveness of current offensive systems;
- raising development and procurement costs for next generation systems;
- enhancing regional security by providing an alternative to offensive deterrence;
- limiting scope of proliferating states missile coverage; and
- providing political flexibility in crises.

Coupling the beneficial effects on regional countries' motivations to proliferate with the fact that they currently are not capable of providing their own defense provides strong leverage for defenses to become a cornerstone in limiting demand for offensive systems. Being a provider of effective defenses will allow the U.S. to use the provision of them as an incentive for countries to cooperate with multilateral anti-proliferation arms control like the Non-Proliferation Treaty. Providing defenses to countries that accede to international monitoring enhances their security without directly threatening the security of other regional countries. Similarly, the deployment of space-based defenses can provide some of these benefits to all countries.

As evidenced in the Middle-East and South Asia, countries currently feel the best way for them to meet their strategic requirements and match their geopolitical rivals is through the acquisition of strategic capabilities. Until these countries can satisfy these concerns with other methods, strategic offensive weapons will proliferate. The best tool the U.S. has to reduce regional security concerns, marginalize the attraction of offensive systems, and entice cooperation in multilateral arms control is the judicious use of its superior defense abilities.

## **6.0 CONCLUSIONS**

Not all the disincentives to proliferation created by defenses are quantifiable. Specifically, no single cost comparison measure like CEATM neatly applies to regional arms races. This does not mean that meaningful measures which describe defenses' disincentives on arms races are not available, only that broader measures and broader analyses are necessary. The singularity of CEATM is nice, but in describing how defensive deployments in a region will affect the regional arms race, a multiple set measures must be examined.

This paper has outlined some measures that describe how defenses will impact procurement decisions for ballistic missile systems. However, no combination of these measures holds the promise of a "good" or "not good" evaluation of certain defenses. The decision processes of proliferators are too complex for that and involve unquantifiable and perhaps illogical considerations. Nonetheless, the quantitative measures identified herein can be useful in analyzing defenses' impacts on regional arms races. These measures of the reduction of strategic utility of ballistic missiles at the margin are important for relative comparisons between defense possibilities and to illustrate defenses' benefits in deterring proliferation.

In fighting proliferation, arms control alone probably will not be sufficient. Regional countries at present see too much military, strategic, and political value in strategic offensive systems to be dissuaded by supply-side cartel measures. Marginalizing the value of ballistic missiles through judicious exploitation of defensive technologies needs to assume a more prominent role in the anti-proliferation program. Meaningful quantitative measures are crucial to build support for the use of defenses in fighting proliferation. The measures introduced in this paper can be developed into this type of support for GPALS. The major aspect of these measures is their focus on the proliferator's marginal strategic effectiveness against established defenses. This provides for tractable, sensible, and meaningful analysis and, thus, a better understanding of the value of GPALS.